Fully Automated Demand Response at Five Test Sites

Mary Ann Piette

Research Director

Demand Response Research Center

Customer Response to Dynamic Prices and Demand Response Programs in California Workshop

June 8, 2004

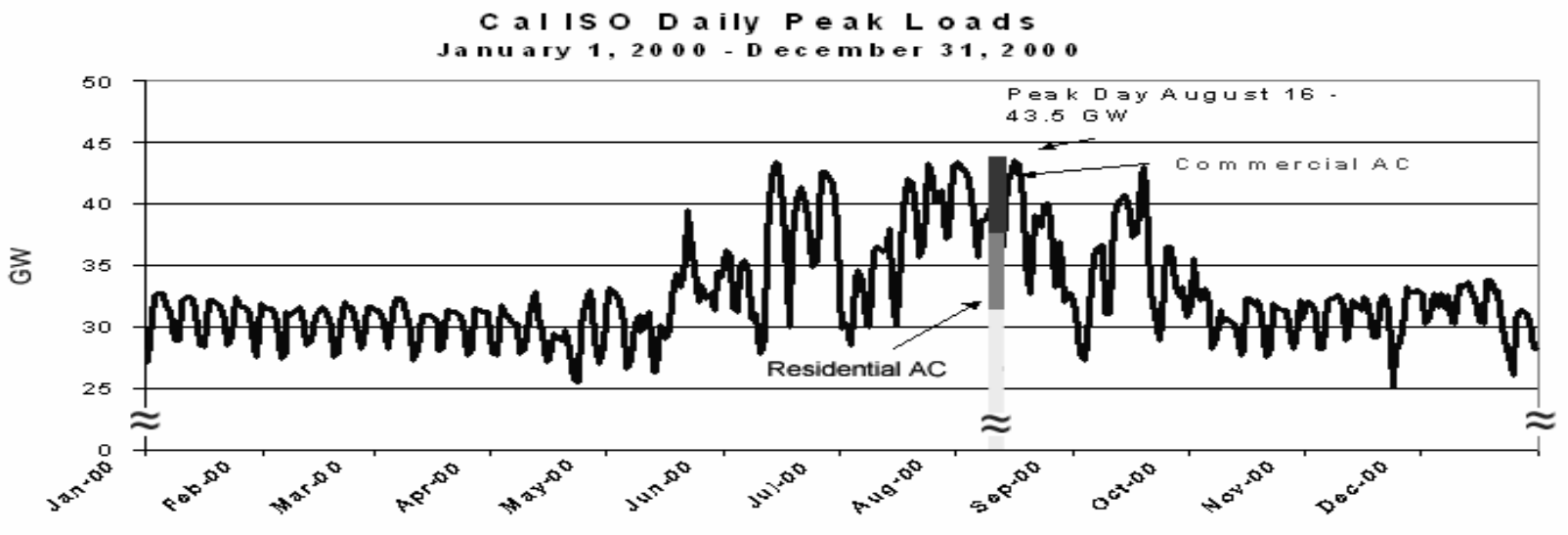
Sponsored by the California Energy Commission

Presentation Overview

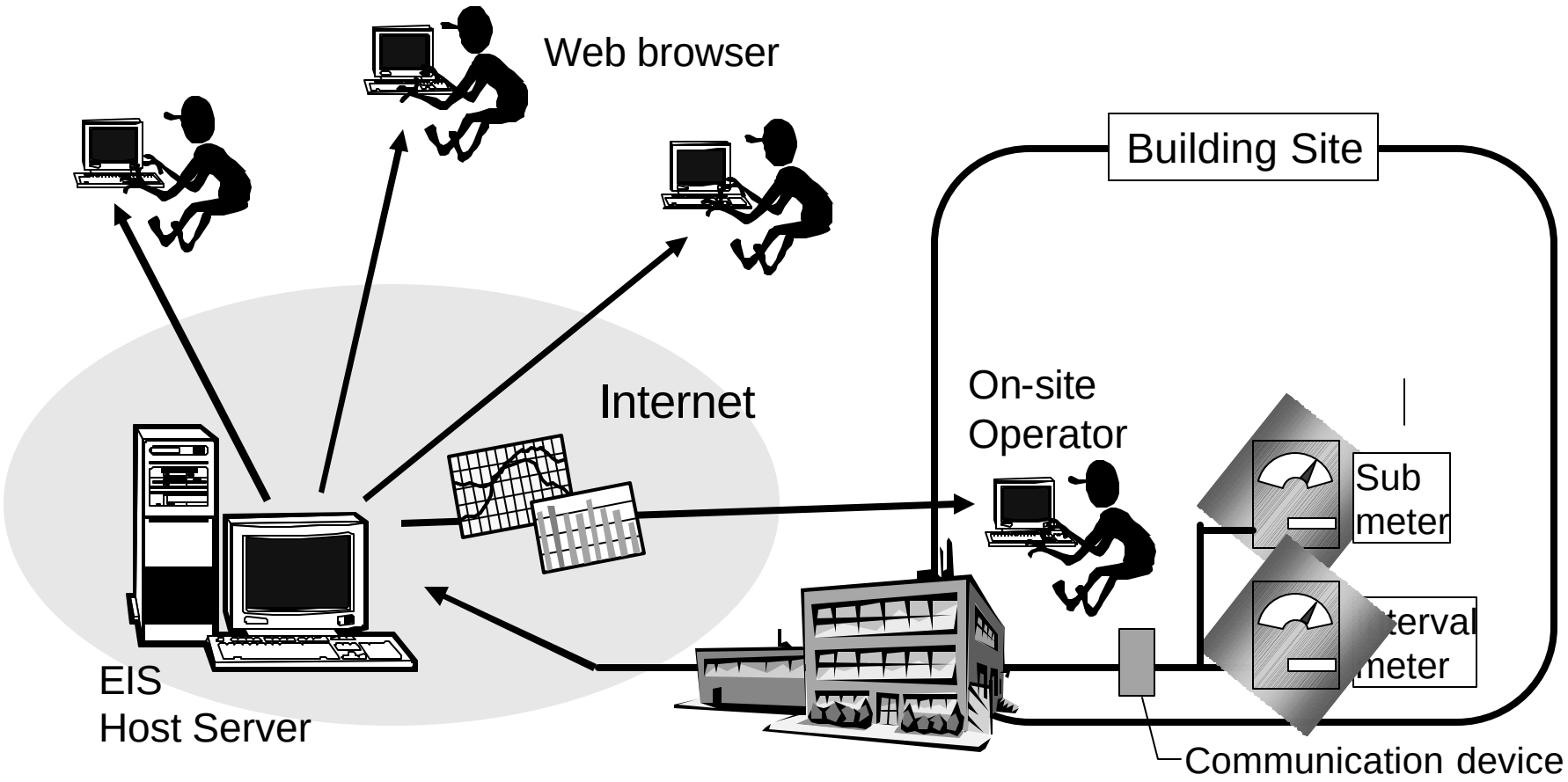
- **Demand Response Concepts**
- **Energy Information Systems**
- **Automated Demand Response Project**
- **Future Directions: Demand Response Research Center**

Demand Response & Project Goal

- **Motivations for Demand Response**
  - **Improve grid reliability**
  - **Flatter system load shape**
  - **Lower wholesale and retail electricity costs**
- **Primary Goal: Evaluate technological performance of Automated Demand Response (Auto-DR) hardware & software systems in large facilities**

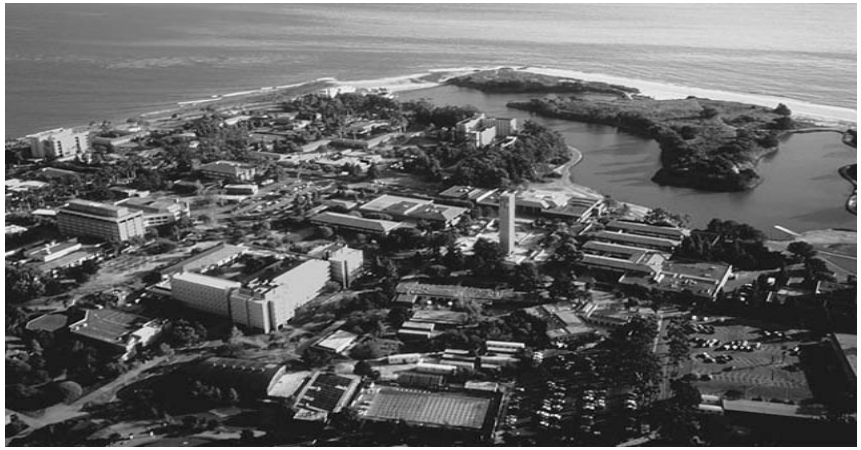


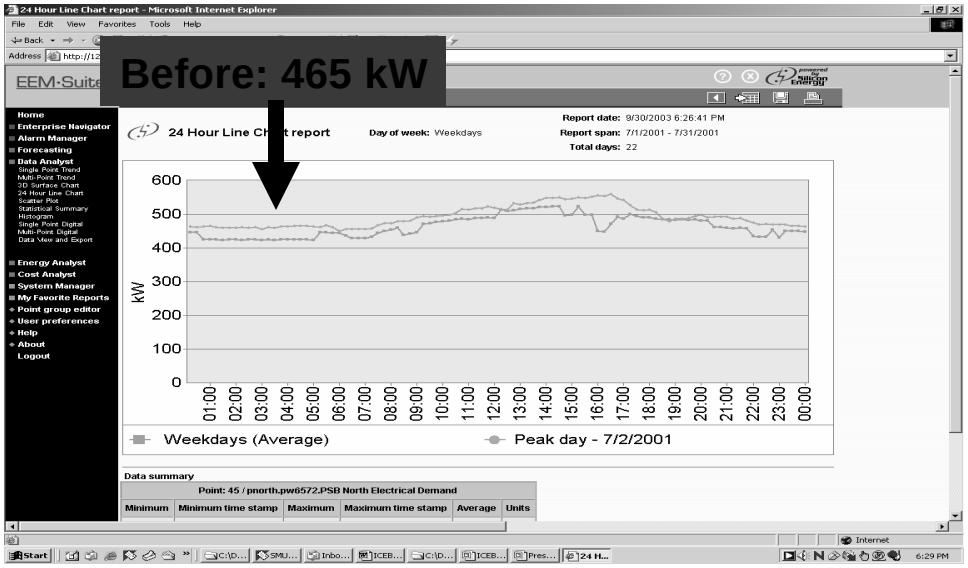
Energy Information Systems

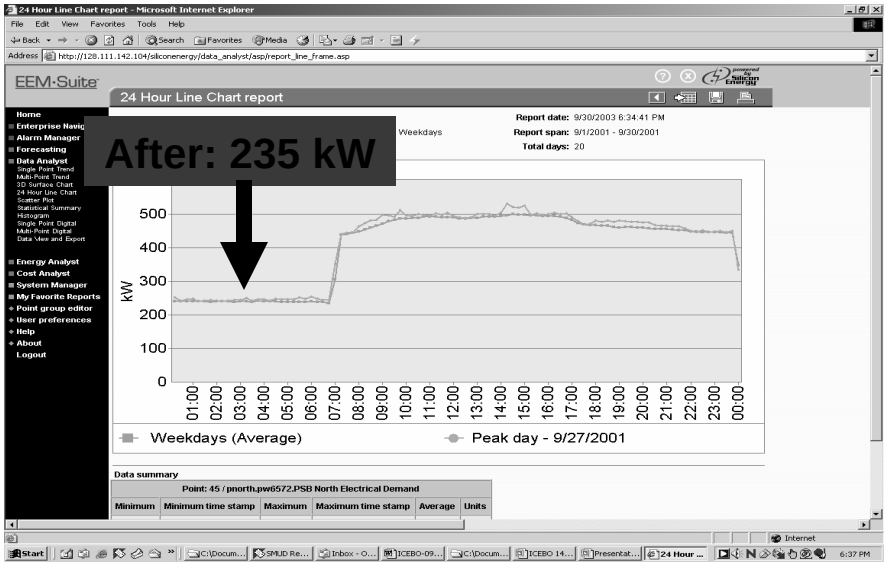


UC Santa Barbara Energy Information System Analysis

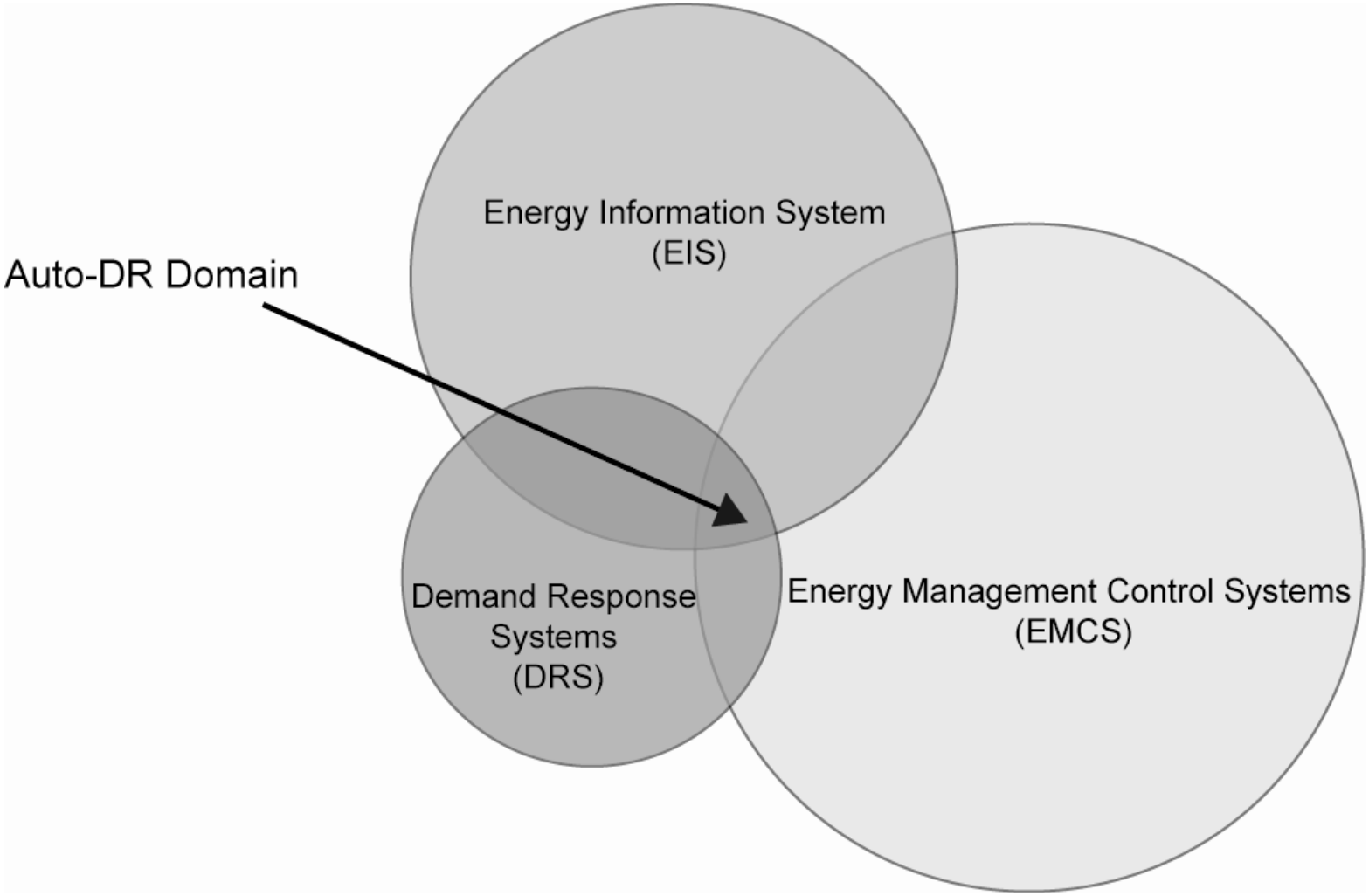
- **Case Study Reviewed**
  - —**EIS Costs (~$300k)**
  - —**EIS Operations (Daily)**
  - —**Findings from the EIS**
  - —**Costs and Benefits**







Types of Web-Based Energy Information Systems (EIS)

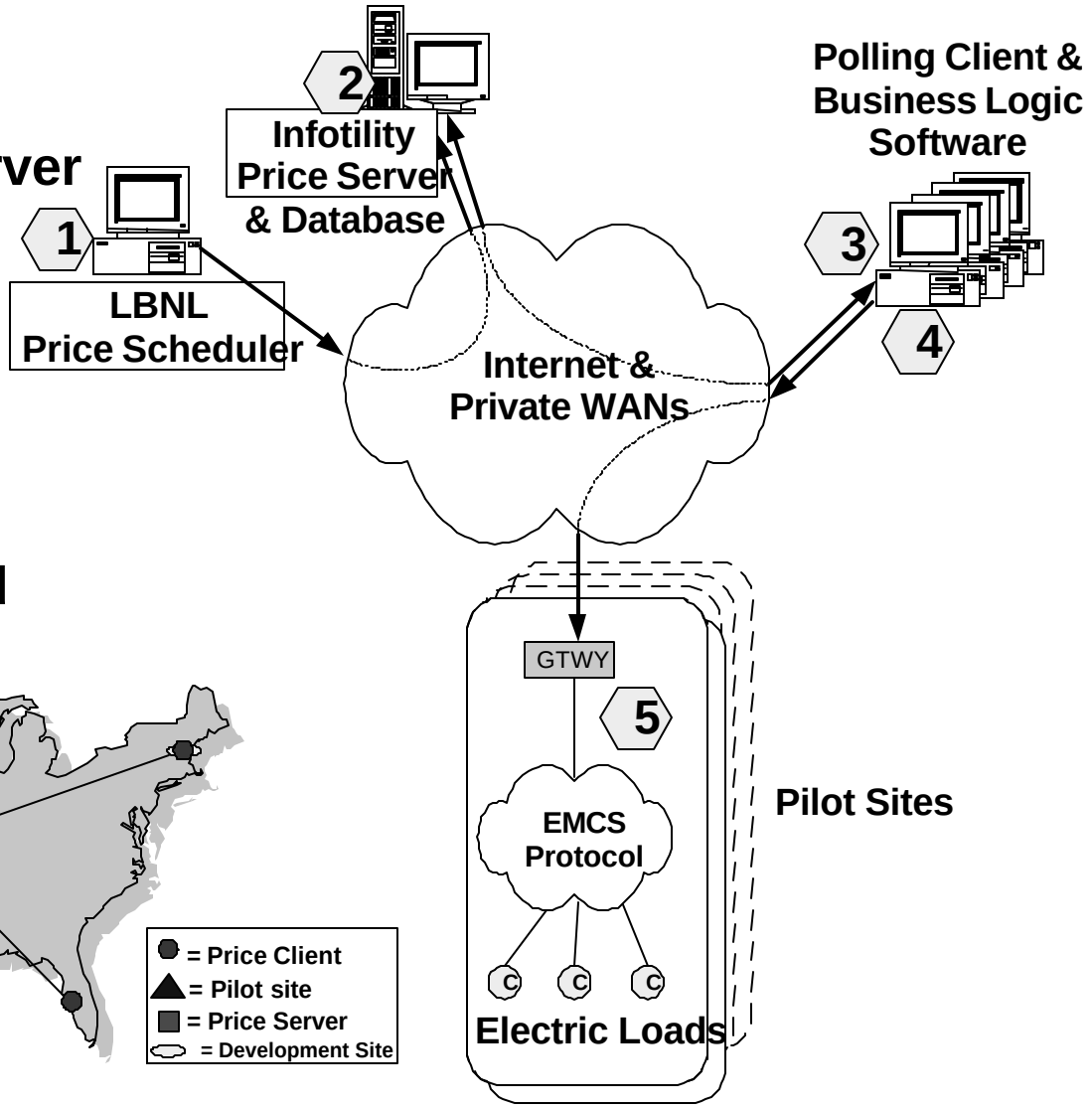


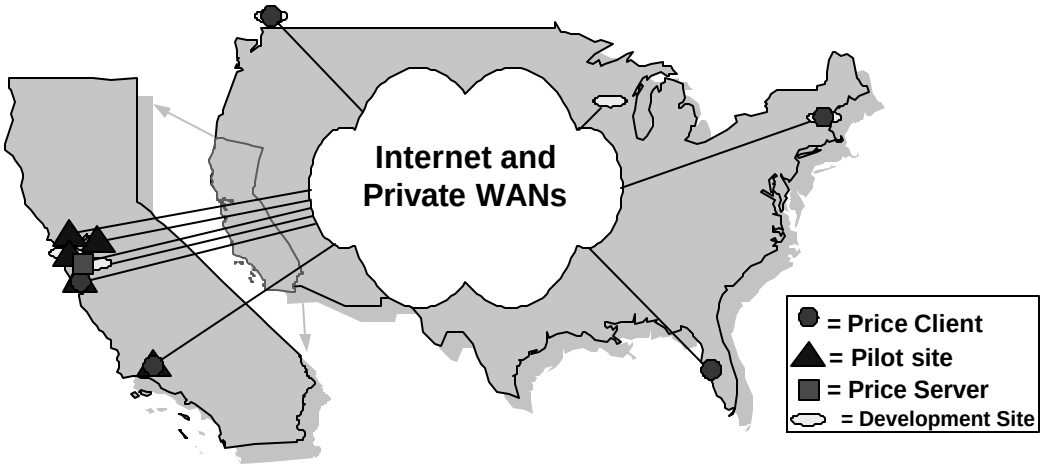
Recruited Sites and EIS

Albertsons – East 9th St. Oakland
Engagenet
Bank of America – Concord Technology Center
Webgen
General Services Admin - Oakland Fed. Building
BACnet Reader
Roche Palo Alto – Office and Cafeteria
Tridium
Univ. of Calif. Santa Barbara – Library
Itron Silicon Energy

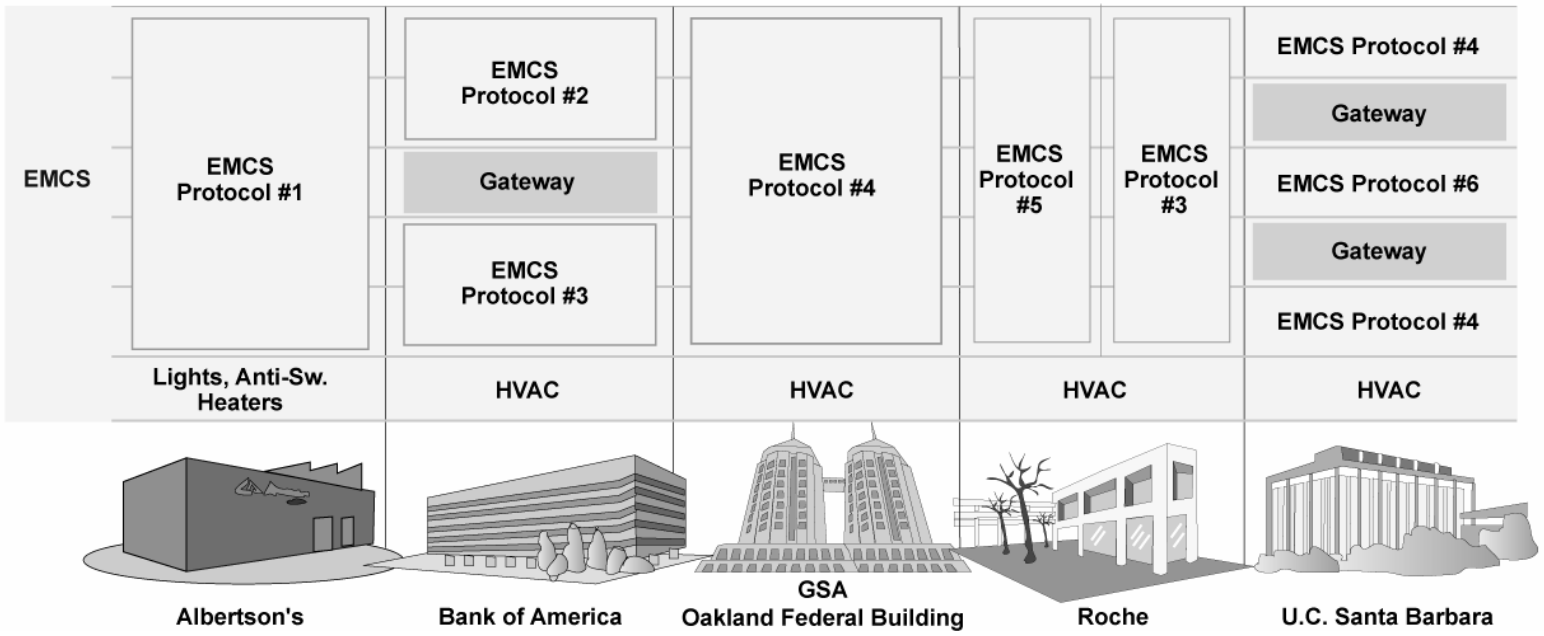
Auto-DR System Communications

1. LBNL defines price schedule
2. Price published on server
3. Clients request price every 1-5 minutes & replies to server
4. Business logic determines response
5. EMCS carries out shed





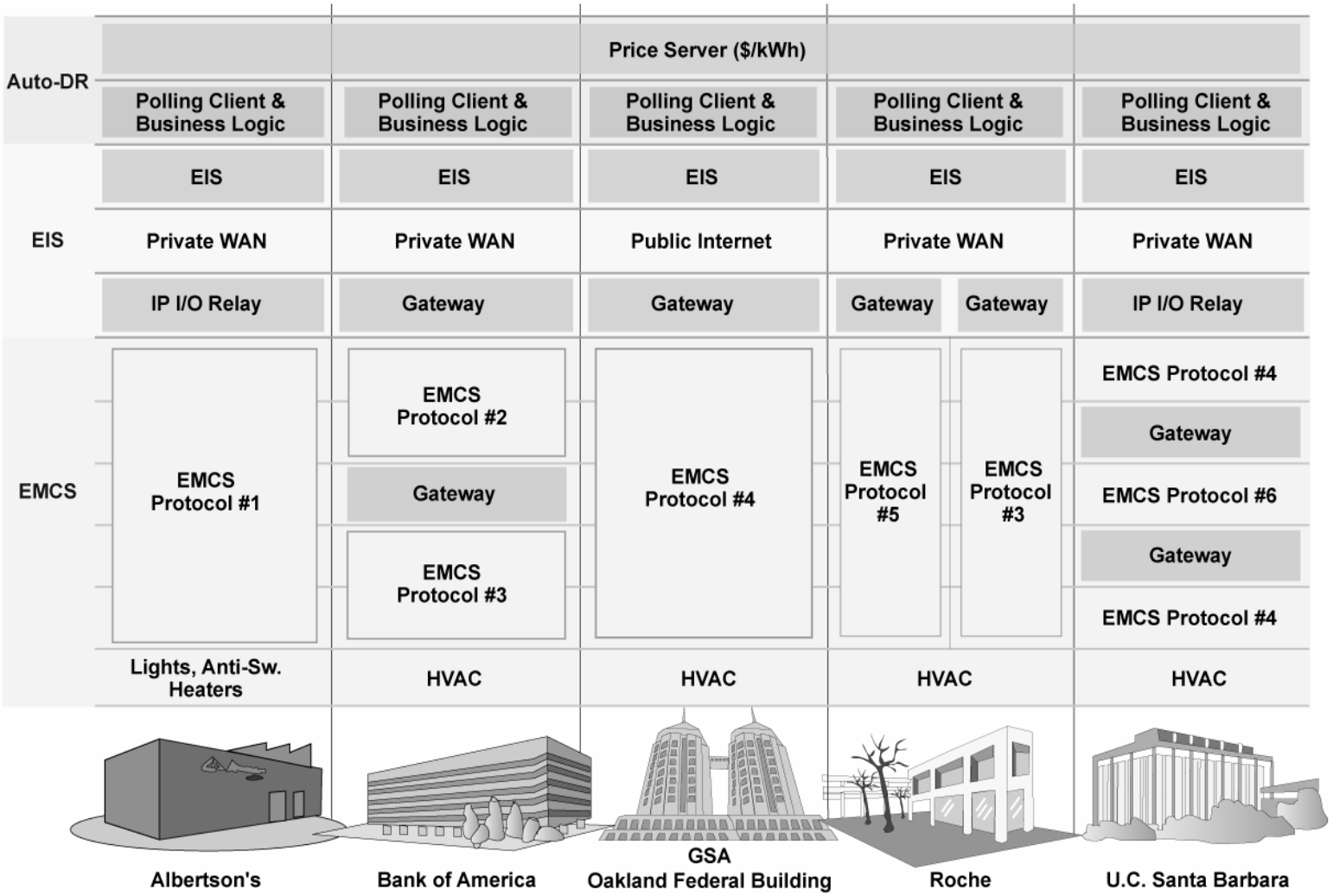
Test Sites - Circa 1999 (1 of 3)



Test Sites - After Energy Crisis (2 of 3)

	EIS	EIS	EIS	EIS	EIS
EIS	Private WAN	Private WAN	Public Internet	Private WAN	Private WAN
	IP I/O Relay	Gateway	Gateway	Gateway / Gateway	IP I/O Relay
EMCS	EMCS Protocol #1	EMCS Protocol #2 / Gateway / EMCS Protocol #3	EMCS Protocol #4	EMCS Protocol #5 / EMCS Protocol #3	EMCS Protocol #4 / Gateway / EMCS Protocol #6 / Gateway / EMCS Protocol #4
	Lights, Anti-Sw. Heaters	HVAC	HVAC	HVAC	HVAC
	Albertson's	Bank of America	GSA Oakland Federal Building	Roche	U.C. Santa Barbara

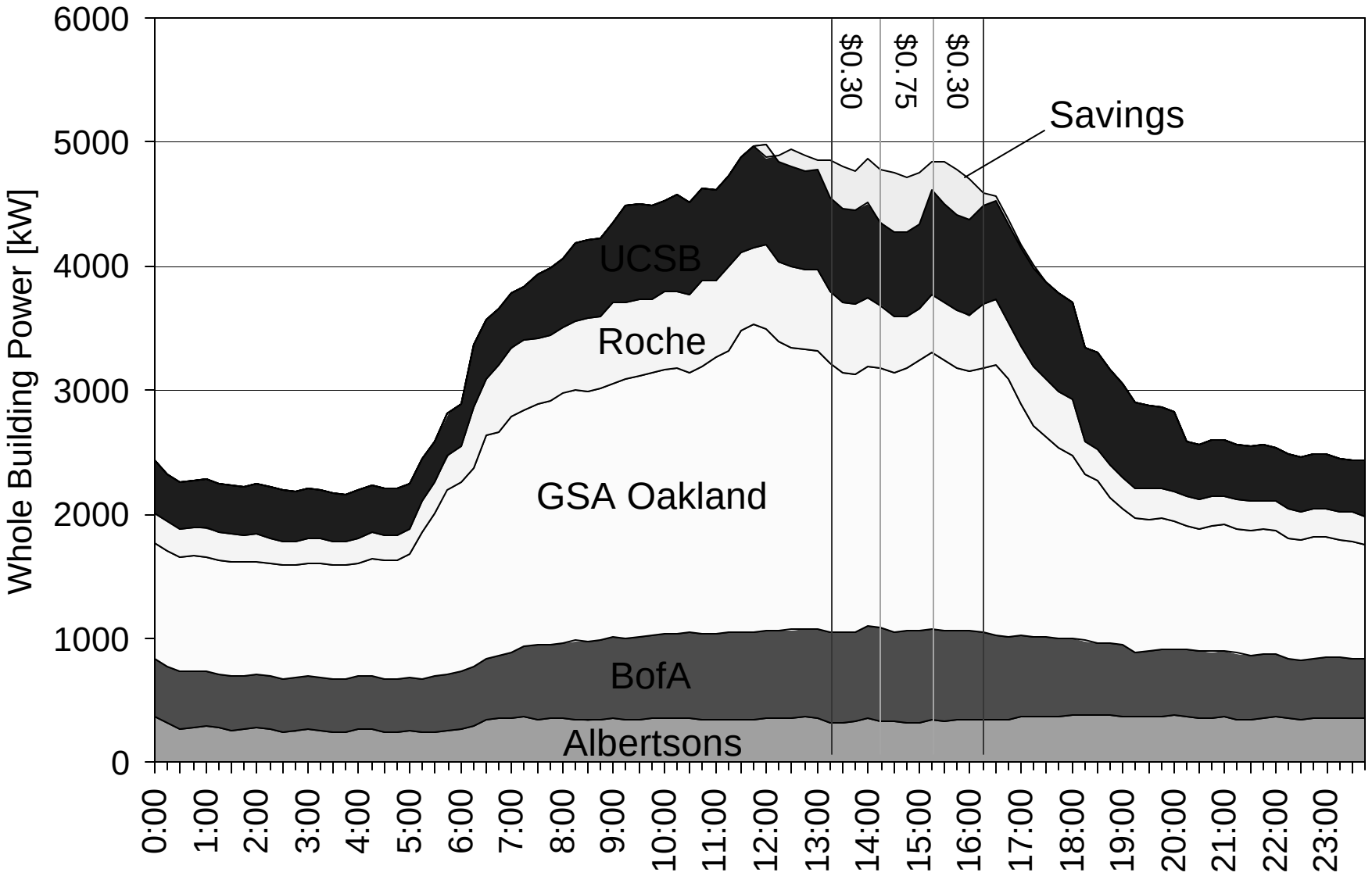
Test Sites –2003 Auto-DR Test (3 of 3)



Two Way Signaling

ChannelID [asc]	Channel Description	UserID	UserName	When requested by user	Timestamp	Price sent by server	Price returned by user	When returned by user
1233	Price_LBNL1	389	gsa,cpu1_	11/19/2003 1:45:22 PM	11/19/2003 2:00:00 PM	0.3	0.3	11/19/2003 1:59:37 PM
1233	Price_LBNL1	402	boa,cpu1_	11/19/2003 1:45:30 PM	11/19/2003 2:00:00 PM	0.3	0.3	11/19/2003 1:46:31 PM
1233	Price_LBNL1	385	ucsb,cpu1_	11/19/2003 1:45:35 PM	11/19/2003 2:00:00 PM	0.3	0.3	11/19/2003 1:46:36 PM
1233	Price_LBNL1	392	roche,cpu1_	11/19/2003 1:45:44 PM	11/19/2003 2:00:00 PM	0.3	0.3	11/19/2003 1:46:44 PM
1233	Price_LBNL1	397	albertsons,cpu1_	11/19/2003 1:47:05 PM	11/19/2003 2:00:00 PM	0.3	0.3	11/19/2003 1:50:13 PM
1233	Price_LBNL1	389	gsa,cpu1_	11/19/2003 2:00:22 PM	11/19/2003 2:15:00 PM	0.75	0.75	11/19/2003 2:14:37 PM
1233	Price_LBNL1	402	boa,cpu1_	11/19/2003 2:00:38 PM	11/19/2003 2:15:00 PM	0.75	0.75	11/19/2003 2:01:40 PM
1233	Price_LBNL1	392	roche,cpu1_	11/19/2003 2:00:44 PM	11/19/2003 2:15:00 PM	0.75	0.75	11/19/2003 2:01:44 PM
1233	Price_LBNL1	385	ucsb,cpu1_	11/19/2003 2:00:50 PM	11/19/2003 2:15:00 PM	0.75	0.75	11/19/2003 2:01:50 PM
1233	Price_LBNL1	397	albertsons,cpu1_	11/19/2003 2:02:05 PM	11/19/2003 2:15:00 PM	0.75	0.75	11/19/2003 2:05:14 PM

Results - Day-2 Test



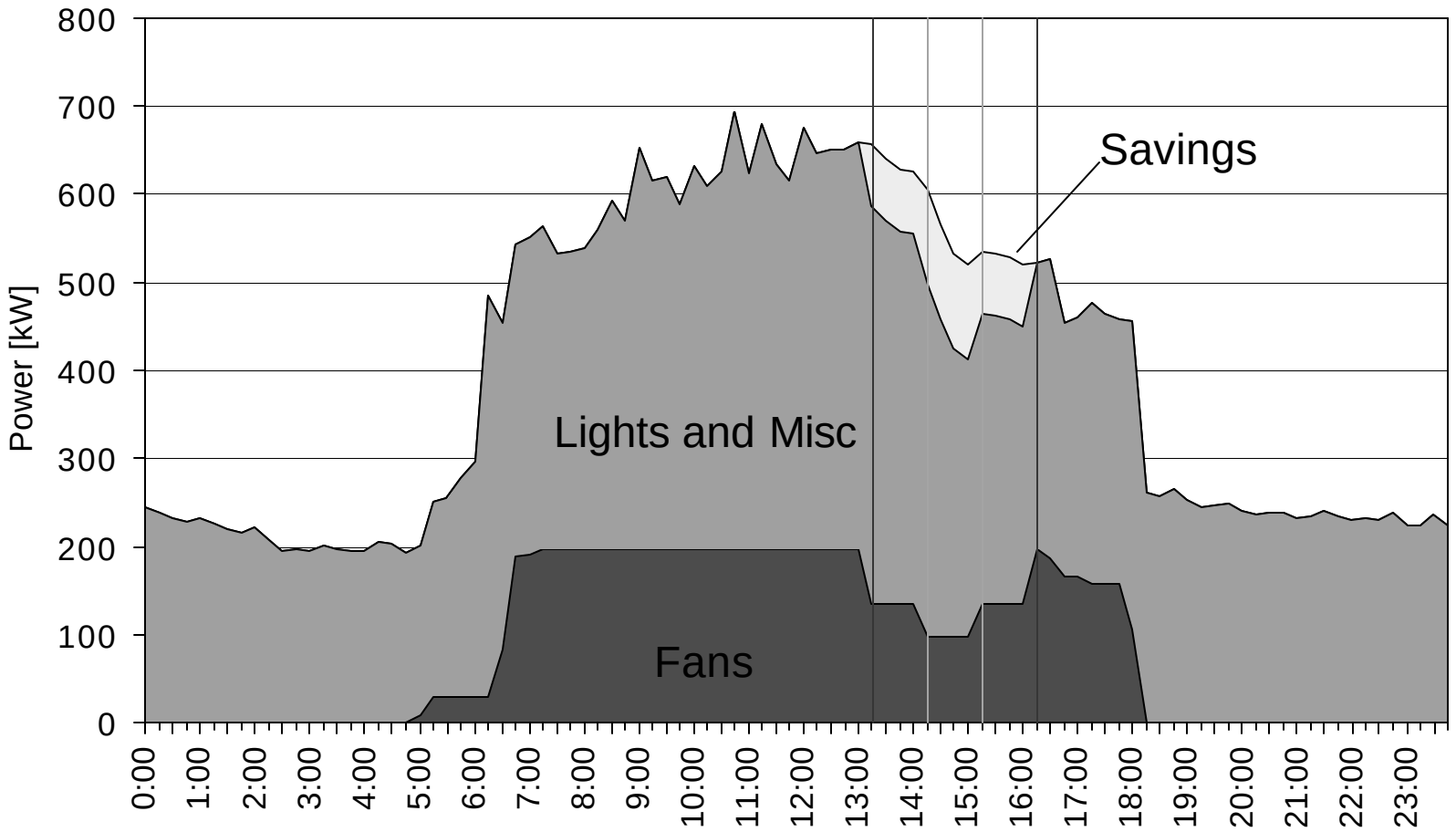
Summary of DR Strategies – Tests 1 & 2

		Albertsons		B of A		GSA		Roche		UCSB	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
HVAC	Global zone set-point increase					×	○				
	Direct control of fans							○	○	×	○
	Reset duct static pressure			×	○					○	○
	Reset cooling and heating valves									○	○
Lighting	Reduce ambient lighting	○	○								
Other	Reduce Anti-sweat Heaters	×	○								

O – Succeeded
X – Planned, but failed

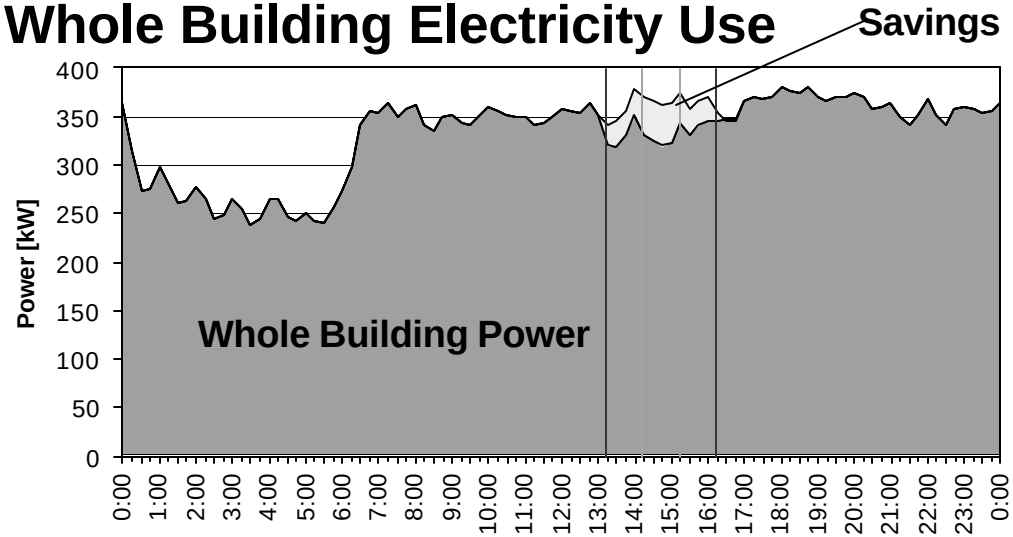
Whole-Building and Component Savings at Roche Pharmaceuticals

Whole Building and Fan Electricity Use

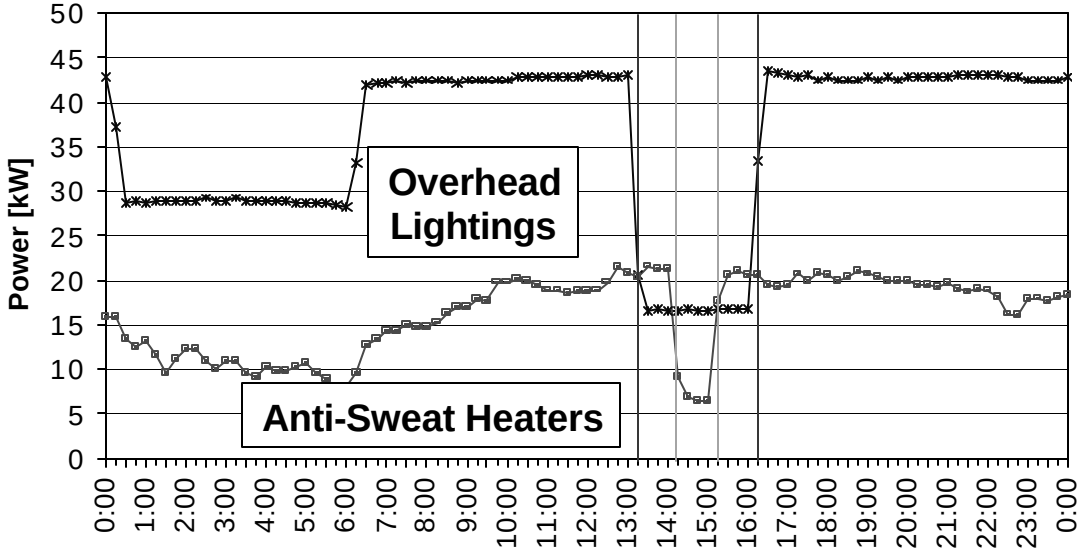


Whole-Building and Component Savings at Albertsons

Whole Building Electricity Use

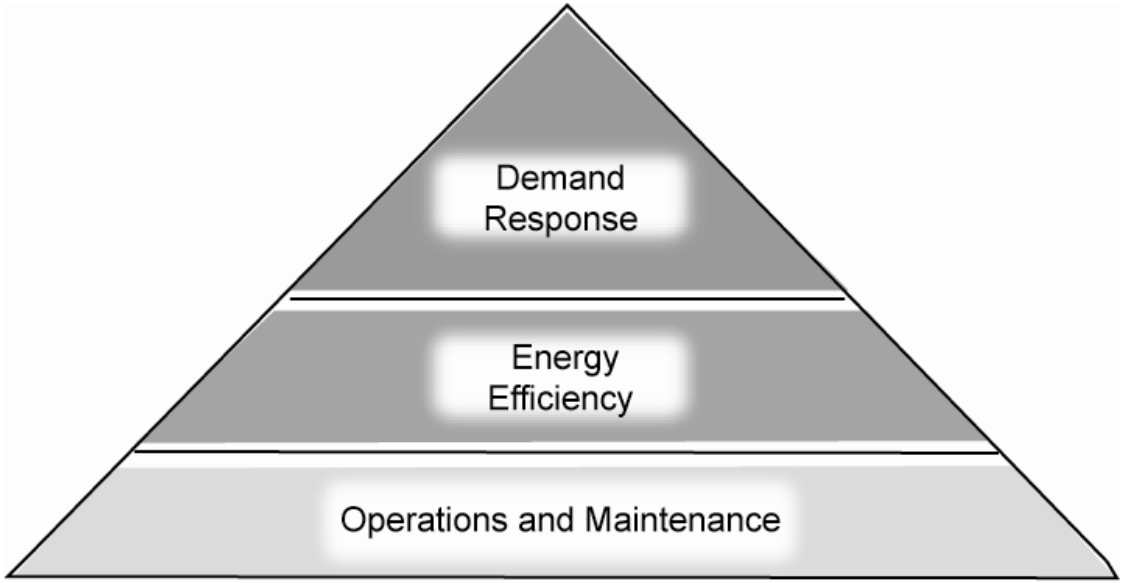


Lighting & Anti-Sweat Heaters



Findings on Automated-DR

- **Fully automated DR is feasible with current technology**
- **Automation enhances demand response programs**
- **Large facilities support the objectives of DR**
- **New knowledge is needed to procure and operate technology and strategies for DR**

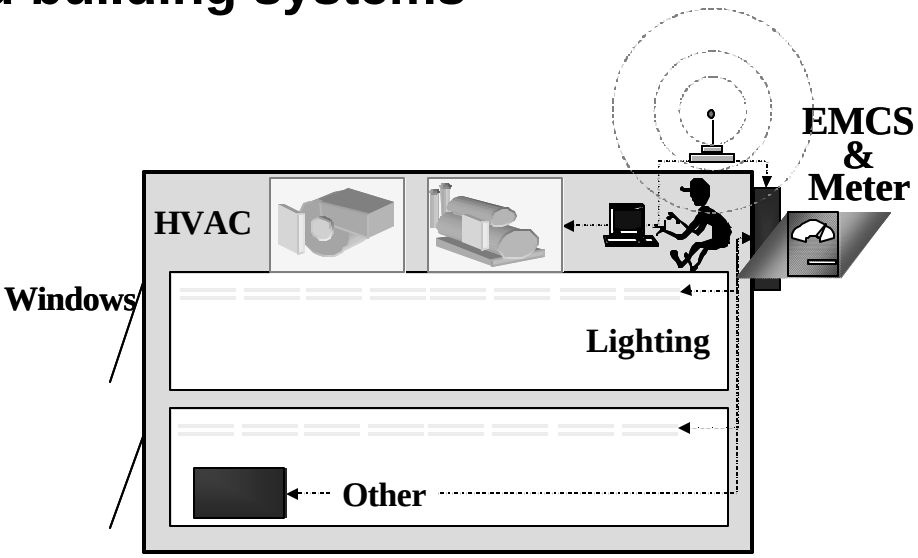


Demand Response Research Center

- **Objective: to develop, prioritize, conduct, and disseminate multi-institutional research to facilitate DR**
- **Scope: technologies, policies, programs, strategies and practices, emphasizing a market connection**
- **Method: Partners Planning Committee, Annual R&D Plan**
- **Stakeholders:**
  - **State policy makers**
  - **Researchers**
  - **Information & metering system developers**
  - **Aggregators**
  - **Program implementers**
  - **Utilities**
  - **Industry trade associations**
  - **Building owners, engineers & operators**
  - **Building equipment manufacturers**
  - **Other end-use customers**

Future Buildings Research

- **Scale Up Automation Research - *Recruiting for 2004!***
  - **Larger sheds (more buildings, more per building)**
  - **Bandwidth, throughput, costs and benefits, security**
- **Review of Control Technologies and Strategies**
  - **Scenarios on economics and building systems**
    - **Lighting controls**
      - Dimmable ballasts
      - Bi-level switching
    - **HVAC control**
      - Thermostat set up
      - Pre-Cooling strategies
      - Fan & chiller control
  - **Real-Time Simulation Tools**



- **Building comfort, productivity, feasibility, behavior**

Further Information

- **Contact: Mary Ann Piette, mapiette@lbl.gov, 510 486-6286**
- **Demand Response Research Center**

  drrc.lbl.gov
- **Current CEC Demand Response Sites**
  - **Consortium for Electric Reliability Technology Solutions (CERTS)**

    certs.lbl.gov
  - **Center for the Study of Energy Markets (CSEM)**

    www.ucei.berkeley.edu/power.html
  - **Demand Response Enabling Technology Development (DRETD)**

    ciee.ucop.edu/dretd
- **Buildings.lbl.gov/hpcbs/Pubs.html**
  - **Case Studies of Energy Information Systems and Related Technology: Operational Practices, Costs, and Benefits**
  - **Web-based Energy Information Systems for Energy Management and Demand Response in Commercial Buildings**